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STUDY OF

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Final Report

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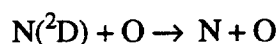
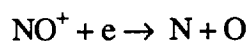
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## Final Report

We investigated the contribution of energetic nitrogen atoms to the production of nitric oxide in the thermosphere and their influence on the infrared emission spectrum. The nitric oxide molecules are important contributors to the cooling of the atmosphere.

We first pointed out that in determining the energy distribution of the nitrogen atoms, it is important to take into account the thermal motion of the atmospheric gases. It had been ignored in all earlier studies. The source spectra are broadened considerably by the center of mass motion of the reactants. We worked out the consequences for the production of nitric oxide at night, using as sources of energetic N atoms,



The high energy tail is enhanced by orders of magnitude. We had earlier suggested (Sharma et al. 1993) that the reaction of energetic nitrogen atoms with  $\text{O}_2$  was responsible for the rotationally enhanced NO identified in the infrared spectrum (Armstrong et al. 1994). Our calculations provided quantitative confirmation of the suggestion.

We proceeded to explore the validity of another approximation used in earlier analyses, the hard sphere approximation for the energy loss in elastic collisions. We carried out precise quantum mechanical calculations of the elastic

differential scattering of nitrogen atoms in collisions with oxygen atoms and showed that although the hard sphere approximation was nowhere of high precision, reasonable results could be obtained with an effective cross section of  $6 \times 10^{-15} \text{ cm}^2$ .

We also initiated a program to include inelastic energy loss processes in the determination of the energy distribution function. We began a calculation of the rotation and vibrational excitation cross sections of molecular nitrogen and nitrogen atoms and developed a method for including inelastic energy loss as a function of scattering angle in the Boltzmann equation. A procedure for obtaining the solution of the Boltzmann equation was worked out.

This research was still incomplete when the grant was terminated. It has proceeded nevertheless, though slowly, and two papers are now in press (Balakrishnan, Kharchenko and Dalgarno 1998, Kharchenko, Balakrishnan and Dalgarno 1998).

Another approximation made in earlier studies is the assumption of a steady-state. We drew attention to the possible effects of time-dependence, which we reported at the 1996 meeting of the AGU (Kharchenko and Dalgarno 1996). This study is not yet complete.

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